XIX. *Experiments and Observations made with the Doubler of Electricity, with a view to determine its real Utility, in the investigation of the Electricity of atmospheric Air, in different degrees of Purity. By Mr.* John Read. *Communicated by* Richard Henry Alexander Bennet, *Esq. F. R. S.*

Read May 15, 1794.

It is scarcely necessary to observe, that having removed the uncertainty respecting the electrical action of this curious instrument, by demonstrating (after much care and pains, as is particularly expressed in my tract on Spontaneous Electricity) that the electricity of the doubler is alone derived from the common electrified aqueous vapour suspended in the air; I shall, without any further explanation, beg leave here to express my thoughts in terms according to that demonstration.

When I employ the doubler to investigate atmospheric electricity, I use it with its revolving plate uninsulated, when opposite to that fixed plate which is insulated; because, with respect to insulation, that position of the doubler exactly corresponds to the insulated and uninsulated parts of my high pointed rod, and of course their electrical accumulation will always be of the same kind in all weak electrifications of the atmosphere. To avoid repetition, permit me here also to mention, that care has been always taken to *clear* the doubler

of its former electric *charge*, before I proceeded to accumulate another.

Some observations which I made some time ago, induced me to suspect that air, by being vitiated even in a small degree in various ways, as by respiration, putrefaction, &c. lost a portion of its natural electricity, and became thereby electrified negatively: the following facts seem to substantiate this supposition. The room I usually inhabit being of small dimensions, is on that account more liable to suffer a change in the electrical state of its air than a larger one; and having been often struck with the constancy of the doubler charging negatively in it, whereas in the open air, and often in the adjoining room, which is larger, the doubler would give positive electricity; I saw nothing to occasion this difference between the two rooms besides what could be attributed to the respiration and to the usual effluvium of my body. I was therefore curious to try on the 9th of July, 1793, whether a change could be effected in the electrical state of the air in the large room by the same means. The weather being very hot and serene, therm. 75°, I invited a second person to sit with me in this room during the space of 20 or 30 minutes, with the door and windows close shut up; I placed myself nearly in the middle, and my companion at the side of the room. At the end of 20 minutes I was in a profuse perspiration, which according to my ideas must promote the business in hand; I therefore worked the doubler, and found the experiment to succeed agreeably to my expectation, as it now gave negative electricity.

Suspecting that similar effects must take place during sleep in my bed-room, which is on the north side of the house, I

examined the electric state of the air both within and without the bed-room a little before I went to rest, and found it positive by the doubler. I arose at six o'clock next morning, and worked the doubler, and it quickly became electrified negatively. But as it often happens, in completing one discovery we get an imperfect knowledge of others, I was surprised to observe, by the action of the doubler, to what a great degree the air in the room was deprived of its insulating quality; for although the doubler accumulated electricity in every revolution strong enough to enable me to ascertain its kind, yet its electric charge was conducted away almost as quickly as obtained.

With a view to determine what happens in the upper part of the house, I went up into the garret, and found it close shut up, and the air within it was excessively hot, and in some degree noxious; therm. 80°. After a very few turns of the revolving plate, the doubler became electrified negatively: I immediately set the door and windows wide open, and another door which opens over a bow window, to let in fresh air; but the wind blowing moderately strong from the east, and the bow window door being at the north end, and the windows at the south end of the garret, made it unfavourable for an east wind to drive through it, therefore its electric state remained the same in kind after they had been opened, as when shut; for I examined it at several intervals of time: yet the state of the air became thereby considerably better to breathe in. These facts will appear still more extraordinary, when we consider that the general state of atmospheric electricity at the time of performing these experiments was of the positive kind, as appeared by the doubler when placed on the wood hand-rail of the bow window, which is only three

feet and six inches out of the garret. Had the direction of the wind been north or south, it would have passed through the garret with force, and would, no doubt, have changed by regular gradation its electricity to positive; a fact that I have often observed to succeed very quickly.

I likewise observed, that when the excessive heat of the sun was full upon any other room in my house, it was capable of effecting a change in their electrical state, excepting in those which were under ground; for in the two kitchens, open area, and coal-vault, the doubler became electrified positively; in the two former rooms speedily, but in the two latter, that lay more to the sun, slowly. I have observed before, that the air in the garret was infected with a noxious exhalation, which I now judge came from the wearing apparel laid up in it: whereas the air in the kitchens was not only much cooler, but perfectly clear of all offensive exhalations. However, on the 17th of July, the two kitchens were white-washed and painted, and of course were filled with a noxious effluvium. The day after, I worked the doubler in the kitchens, and by a very few turns of the revolving plate it gave negative electricity.

Knightsbridge charity-school fills up a piece of ground between the north end of the chapel and Hyde-Park wall; and the main sewer of that neighbourhood runs at no great depth under it; the number of children educated in this school is thought by some to be too great for the size of the school; on these accounts it becomes infected with a very disagreeable stench, especially when the door and windows are shut up; I have sometimes found the noxious effluvium so very strong in this school, that I have hastened out to breathe a purer air. I have often examined the electrical state of the air in this

school with the doubler, and have always found it strongly negative; which shewed that the aqueous or other conducting matter lodged in the air of the school, possessed less than their natural quantity of electricity; while that of the schoolmaster's parlour adjoining, having nobody in it, possessed somewhat more than its natural quantity, it was found therefore positively electrified.

July 5th, therm. 76°, I went to the school, and found the door and windows set wide open to let in cool air; I now perceived no stench at all in the school, and thought it needless to try it. However the schoolmaster observed that the further end of the school was at all times most infected with, and seldom quite clear of stench. I therefore worked the doubler in that part of it, and after a very few turns it became electrified negatively, rather against my expectation. I then tried the other end of the school, which, by the door being wide open, was less liable to retain any noxious effluvium, and there the doubler gave positive electricity. After this I tried it in the schoolmaster's parlour, where it was positive also.

July 30th, I had the curiosity to examine with the doubler the electrical state of the air in the wards of the Lock Hospital. In the two small men's wards it was found negative in every part. The floor of the large or long ward had been washed, and the boards were still wet; the windows in the east side, and the large one in the south end, were all open; therefore there was but very little offensive smell in the south end of this ward, and here the doubler became electrified positively: but the great window in the north end of this ward being close shut up, caused a sensible closeness in the air, accompanied with a slight smell; and in this end of the ward the doubler

gave negative electricity. The door and all the windows in the women's long ward were set wide open; the open windows at each end of this ward being nearly in the direction of the wind, gave it a complete passage through it; of course, the wind blowing at that time with a brisk gale, ventilated this ward completely, for there was no offensive smell in it; however, I tried the state of the air in several parts of it with the doubler, in all of which it gave positive electricity, the same as it would have done in the open air on the outside of the building.

December 6th, I observed in the garden a heap of the loppings and leaves of shrubs, in a state of putrefaction, which induced me to examine their volatile effluvium with the doubler, which I placed upon the heap, and on working it, it became possessed of a weak negative electricity; for it required more than thirty turns of the revolving plate to effect a good charge, whereas in the privy (which is at a small distance from the heap of leaves) the doubler became strongly charged with less than half that number of turns, and with the same kind of electricity. This, indeed, I expected would have been the case, because I have always observed the doubler to give negative electricity in a privy; but that the rotten leaves should be able to maintain that electric state in the open air, is truly wonderful, when it is considered that the surrounding atmospherical electricity was of the positive kind, and rather strongly so, both by the doubler and the high pointed rod. I am of opinion that I should not have given due attention to this fact, if it had not so happened that the doubler had not been used for near two weeks before; it was therefore evident, that it

must have been wholly deprived of every particle of its former charge.

The day after this, the heap of leaves was laid open, and every twig and leaf exhibited a covering of white mould; but after this, the doubler always gave the same kind of electricity when worked on the leaves, as in any other part of the open air, namely, positive. In order to be fully satisfied in this matter I determined to try it on a large dunghill, whence a greater quantity of putrid effluvium must ascend. I also resolved to make the experiment when the air was sharp and frosty, because then the atmospheric electricity is not only of the positive kind, but uniformly the same in all places, from the surface of uncontaminated earth to any height we can go. The weather on the first day of January, 1794, was quite such as I desired for this business, that is, it was frosty, and accompanied with a very slight dry fog, therm. 31°.

I conjectured that Mr. TATTERSALL (a dealer in horses in my neighbourhood) might be possessed of a large dunghill; I therefore went to his house, and was taken into his garden, where there was a great quantity of it. I first went upon the highest part of the dunghill, and held the doubler in one hand a little above the dung, yet within the reach of the ascending pale coloured vapour, and with the other I turned the revolving plate five or six times, by which means the doubler became electrified positively; which was known to be at that time the general electrical state of the atmosphere. The doubler was now lowered, and placed upon the dung; and here also it became charged by a few turns of the revolving plate, which made me suspect that I had not completely cleared the doubler

of its former charge; however, on trial it was found to be electrified negatively. This remarkable fact fully satisfied me that I had not deceived myself in the first experiment on the heap of leaves above mentioned.

I repeated these experiments, with the doubler placed on various parts of the dunghill, without any remarkable variation in the results, except that the negative state of the exhaled vapour was stronger, and extended to a greater distance, in the depressed or hollow parts of the dung, where the vapour was less exposed to a moderate gale of wind that then prevailed, than on the open parts which lay full to it. I have reason to be of opinion, that the negative state of the vapour on the windward side of the dung did not reach so high as the revolving plate of the doubler when turned up, so that in every revolution it must pass through electrified and neutral vapour, which required in those situations from thirty to forty revolutions to obtain a small charge. From this circumstance I am inclined to think that if a doubler were made of very small dimensions, and placed in the neutral space between the two electric powers, it would be impossible to accumulate with it any spontaneous electricity.

I was solicited to try the state of the air in the hot-house with the doubler, to which I very readily consented. I found the air in it agreeably warm, and full of moisture, which was condensed on the glass roof, and fell down in large drops. The doubler also, having been long exposed in frosty air, quickly attracted and condensed the humid particles upon itself, so as to form a coating on all its parts. I therefore hastened to make the experiment; yet under all these unfavourable circumstances the doubler became electrified negatively after about

fourteen revolutions. As I perceived no smell in this close hot-house, I am inclined to attribute the negative electric state of the vapour to the heat of the fire and vigour of the plants, which possibly may absorb the fluid faster than it could get in through the floor, which is rendered very dry by flues that lie on three sides of it.

Without even attempting to consider in this place how far the influence of electricity is concerned in all sorts of vitiated air, it will be sufficient to remark, as it clearly follows from the preceding experiments, that air infected with animal respiration, or vegetable putrefaction, is always electrified negatively, when at the same time the surrounding atmosphere is electrified positively.